# An Evaluation of Walleye Population Restoration Efforts in the Lower Milwaukee River and Harbor, Wisconsin, 1995-2003

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# Executive Summary


With the removal of the North Avenue Dam on the lower Milwaukee River in 1990 several miles of upstream waters were made available to migratory as well as resident species whose movements were restricted until then by the Dam. In addition, WDNR implemented some major habitat improvement activities in the formerly impounded area in 1997. Surveys indicated many new fish species recolonizing the area as the water quality and habitat progressively improved. This project was aimed at attempting to reintroduce walleye (*Sander vitreus*), one of the native species in the Milwaukee River system, which became insignificant due to Damming and poor habitat conditions. Additionally, it was envisioned as an alternate source of nearshore fishing due to a declining yellow perch population.

Approximately 10,000 extended growth Great Lakes strain walleye fingerlings were stocked annually since 1995 in the Lower Milwaukee River downstream of the former North Avenue Dam. The fish were individually marked to identify their year-class either by a single finclip or by using a Visible Implant Elastomer (VIE) mark. Predation impact, if any, caused by walleye on stocked salmonid smolts was monitored each year soon after releasing the salmon smolts by capturing and analyzing stomach content of the predators. Considerably higher predation impact was noticed in 1996 and 1997 during the first ten days post-stocking. Based on this information, the stocking location for Chinook salmon (*Oncorhynchus tshawytscha*) smolts was relocated to McKinley Marina, several miles away from the location of walleye stocking. This change eliminated the loss of Chinook salmon smolts due to predation immediately following stocking. A net pen was also used to acclimate the salmon smolts to the lake water by holding them over night in the marina water.

A comparison of growth and survival rates between the walleye marked with two different marking techniques (finclip vs. VIE) did not show any significant differences. A cost benefit analysis indicated no obvious benefits using elastomer marking. VIE marks were detectable in walleye as old as 5 years, however, the retention rate appeared to decrease with age.

In general, growth rates of these walleye were greater than statewide average growth rate for walleye populations (average growth rate of 100mm per year in the first three years in the Milwaukee harbor). Mature and spent walleye were recorded during spring spawning assessments beginning in 1998. However, we have not yet documented successful natural reproduction in the system. Population size estimated based on all age groups of walleye varied from year to year, the most recent estimate in 2003 ranged from 401 to 2388.

Radiotelemetry technology was used to track movement by surgically implanting a radiotransmitter into the body cavity of walleye. The data indicated a distinct seasonal movement pattern by the adult walleye according to water temperature and food availability. During the summer they moved from the rivers to cooler and deeper harbor waters. In winter they moved to the warmer waters in the Menomonee River canals which receive warm water discharges from a nearby power plant. There is a significant angling effort targeted towards walleye in recent years along the Menomonee River canals, Summerfest lagoon and in the Milwaukee River upstream of the former North Avenue Dam to Kletzsch Park. Most of the anglers practice catch-and-release.

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## 1.0 BACKGROUND

The lower Milwaukee River has gone through some major changes in recent years, especially since the North Avenue Dam was breached in 1990 followed by a complete removal in 1997. The water quality has been improving due to several pollution prevention measures. The Wisconsin Department of Natural Resources (WDNR) has added some fish habitat enhancement structures in the channel and in the previously impounded area. These enhancements include the placement of 600 tons of limestone riprap and 200 tons of fieldstone boulders as instream habitat and the use of 25 willow trees as bank cover. Bank stabilization included the use of limestone riprap as toe protection, live willow cuttings and the construction of nine bendway weirs (WDNR 1994). While these changes are certainly benefiting anadromous trout and salmon, there appears to be an increase in the diversity of native fish species. The walleye (*Sander vitreus*), one of the native species of the Lower Milwaukee River and the harbor, has almost disappeared due to poor habitat quality. Until the early 1990s the nearshore anglers were dependent on the Lake Michigan yellow perch (*Perca flavescens*) as the main source of sport fishing opportunity for native fish in the area. However, the dramatic decline of yellow perch in the 1990s left very little opportunity for the local nearshore angling community. Since 1986, WDNR has attempted to improve the nearshore fisheries in the Lower Milwaukee River and Harbor by stocking fry and fingerling walleye, northern pike and smallmouth bass (Table 1). However, fry stocking did not appear to be effective, especially with walleye. A small number of yearlings and age 2 walleye were stocked in different parts of the harbor and nearby open water sites including Green Can Reef in 1990 and 1991. Surveys conducted in subsequent years by WDNR suggested very limited survival. A combination of circumstances caused by the removal of the North Avenue Dam and the dramatic decline in the nearshore yellow perch fishery produced further impetus to rehabilitate walleye in the Lower Milwaukee River and harbor.

## 2.0 GOALS AND OBJECTIVES

The long-term goal of the project is to develop a self-sustaining walleye population in the lower Milwaukee River and harbor. In 1998, a detailed Milwaukee River Walleye Restoration Plan (WDNR 1998) was developed with the help of public input. The project, as it progressed, encompassed several objectives to accomplish this goal without negatively impacting the existing fishery. They include:

1) To stock 10,000 extended growth Great Lakes strain walleye each year through 2004,

2) To evaluate predatory impact, if any, by the stocked walleye on stocked Chinook salmon smolts that were stocked in the same area,

3) To evaluate an alternate marking technique using Visible Implant Elastomer (VIE) technology,

4) To examine and document natural reproduction,

5) To estimate population size,

6) To determine growth and survival of stocked walleye,

7) To determine movement and seasonal migration patterns using radio telemetry, and

8) To assess their contribution to the nearshore fishery.

## 3.0 STUDY AREA

The study area encompassed the Milwaukee harbor and the waters of three rivers - the Milwaukee, the Menomonee and the Kinnickinnic - from their confluence up to the first Dam. The outer harbor encompasses about 607 ha which includes the area inside the South Shore breakwalls (Figure 1). The harbor is dredged to maintain navigable depth. The estuary includes the lower Milwaukee River downstream of the former North Avenue Dam which is channelized for navigation (3.1 miles/5.0 km), the lower Menomonee River downstream of 35th Street (3.0 miles/4.8 km), the lower Kinnickinnic River downstream of Chase Avenue (2.5 miles/4.0km), and the inner and outer harbor (Milwaukee Estuary RAP 1994). These rivers flow through highly urbanized areas of Milwaukee before draining into Lake Michigan. The Milwaukee River is one of the major tributaries to Lake Michigan in this part of the state. Since the North Avenue Dam was completely removed in 1997, the next Dam impassable for walleye is located in Theinsville, about 19.7-river miles/31.5 km upstream from the mouth of the Milwaukee River. The flow rates and the water conditions in the rivers are highly variable due to changes in precipitation and Dam operations. The Milwaukee River is wide and shallow (wadable) in this stretch. The WDNR has recently added some habitat enhancement structures in the lower Milwaukee River to improve fish habitat. Some areas of the harbor have dense patches of submerged rooted vegetation providing nursery habitat for many fish species. There is limited amount of spawning or nursery habitat in the upstream waters except some wetland habitat where the Lincoln Creek drains into the Milwaukee River (Will Wawrzyn, WDNR, Personal communication). The annual water temperature varies from ice over in the winter to as high as 32 $^0$C in the summer.

## 4.0 RECENT STOCKING EFFORT

### *4.1 Stocking initiation and funding*

In 1995, with initial funding support of $10,000 from the Lakeshore Fisherman Sports Club, WDNR developed a plan to raise and stock extended growth (150-180mm, total length) walleye fingerlings as part of the walleye population restoration effort (Table 2). Since then, the project has evolved to include many other aspects to understand and evaluate the developing walleye population in the area, and its impact on other species, as well as angler response. The funding for stocking, as well as subsequent evaluation of the performance of the stocked fish, was a critical factor from the inception. However, as the project evolved and progressed, we received a lot of support from our external partners who provided money for raising extended growth walleye fingerlings and purchasing equipment (Table 3). Currently, the project is funded by WDNR to continue annual assessment and monitoring.

### *4.2 Egg source and genetic integrity*

Initially, walleye fingerlings for stocking were obtained from regular walleye stocks. The 1998 plan called for the use of only Great Lakes strain walleye for stocking. Genetic tests were performed by the Illinois Natural History Survey laboratory to determine if eggs collected from populations of walleye to raise extended growth fingerlings conform to the Great Lakes strain. Walleye from the Wolf River, Winnebago system, Fox River and Puckaway Lake were determined to be genetically similar to each other and to other Lake Michigan strain walleyes. This allowed the flexibility to obtain eggs from various locations for raising walleye fingerlings for the Milwaukee River Walleye Restoration Plan.

### *4.3 Stocking method and results*

The walleye fingerlings were stocked each year in October at a predetermined location just downstream of the former North Avenue Dam (Figure 1). This location was selected for a combination of factors including easy access and good habitat. It is a transition area between the riverine condition and lacustrine condition. The water is deep enough that it will provide safer winter conditions for newly stocked fingerlings to survive. Although our goal, per the 1998 walleye plan, was to stock 10,000 extended growth fingerlings consistently every year through 2004, we were not able to achieve that goal in some years due to various circumstances (Table 2). No fingerlings were stocked in 1997 in order to develop the final management plan. Only a limited number of extended growth fingerlings were stocked in 1998 due to high mortality in the rearing pond at a private hatchery. Due to poor hatching and poor survival of fry at the hatchery in 1999, only small fingerlings were stocked. These fingerlings were not marked to identify their year-class. All other years the large fingerlings were given a year-specific mark. As there were only a limited number of finclip options available, the finclip mark had to be repeated starting in 2001. (For example, RP clip that was used in 1995 was repeated in 2001, and so on.)

## 5.0 MONITORING OF PREDATORY IMPACT ON STOCKED SALMONIDS

The 1998 plan called for ongoing monitoring to evaluate the predatory impact of the stocked walleye on stocked salmonid smolts. This was one of the main concerns that the local trout and salmon sport fishermen expressed initially. The Milwaukee allotment of 144,000 Chinook salmon smolts for Lake Michigan were generally stocked at the same location in May where the extended growth walleye fingerlings were intended to be stocked in the following October. In 1996 and 1997 we followed a study designed to examine the worst case scenario of predatory impact. Both years we stocked extended growth walleye fingerlings at the same location as that of Chinook salmon smolts.

### *5.1 Sampling method for collection and analysis of stomachs*

Predator stomach samples were collected at three time periods following stocking of Chinook salmon smolts in May 1996 and 1997. Intense sampling was conducted using a pulsed DC electroshocker (boomshocker) at night to capture at least 100 walleye with full stomachs at each time period. The first sampling was carried out on the night following stocking of Chinook salmon smolts. The second and third samplings were conducted one week after stocking and three weeks after stocking. This approach was set up to examine how smolt dispersal would be reflected in the stomach samples. The stomach contents were expelled from the stomach by using a non-lethal stomach pump (SOLO Pressure Sprayer, 1 gallon with ¼ inch diameter tube). Water under pressure was pumped into the stomach of the fish through a tube, and the contents were forced out and then collected into an enamel tray. The fish was safely released after collecting biological data. The stomach contents were stored on ice in a whirl pack bag and analyzed the following day at the laboratory.

### *5.2 Results*

In 1996, 144,250 Chinook salmon smolts were stocked in the Milwaukee River on May 6 and the sampling for walleye occurred on the nights of May $8^{th}$, $15^{th}$ and $26^{th}$. Using a pulsed DC electroshocker we captured 157 walleye that were stocked in October 1995 of which 25 (15%) of them had one or more semi-digested Chinook salmon smolts in their stomach. On the first sampling event (5/8/1996) we captured 36 walleye of which 14 (39%) had one or more smolts. The second sampling occurred on 5/15/1996, and we captured 85 walleye of which 11 (13%) had one or more smolts (Figure 2). In one week there was a significant drop in the number of walleye stomachs containing smolts. The third round of sampling occurred on 5/29/1996 and we captured 36 walleye. At this time none of the walleye stomachs tested contained any smolts. The average size of the 1995 year-class captured in May 1996 was 160 mm. There were a few stray occurrences of larger walleye in the sample from previous years of stocking (Table 1). Although the initial two rounds of sampling showed walleye with Chinook smolts in the diet, by the third week other food items such as non-salmonid fish and invertebrates dominated the stomach content. This may suggest that Chinook salmon smolts disperse in about 2-3 weeks and thus were not available for predation.

We followed the same method in 1997 (Coffaro et al. 1996) except that we added one more day of sampling to examine and document pre-Chinook stocking predator diet. On 4/28/1997 we conducted a pre-Chinook stocking predator survey in the area that was going to be stocked with Chinook salmon smolts and captured 17 walleyes. None of these walleye had salmonid smolts in their stomachs. Many had food items other than fish and only 3 had fish parts. A study of walleye diets in Oneida Lake, New York suggested that early June diet consisted of mostly chironomids, amphipods and other invertebrates (VanDe Valk et al.

1994). On 5/7/1997, 181,000 Chinook salmon smolts (Avenue total length 85mm) were stocked in the same location where walleye were stocked the previous fall. The first round of sampling on the night of May 8th resulted in 38 out of 46 walleye captured (83%) having one or more Chinook salmon smolts in them, indicating an artificial abundance of food. The proportion of walleye containing Chinook salmon smolts in their stomachs dropped very quickly in the subsequent sampling to as low as 3% by the third week (Figure 2). Again, this change could be the effect of the dispersal of the smolts.

In addition, we collected some more walleye in the harbor using gill nets set overnight. These fish were captured in September 1997 when we were sampling for yellow perch. However, we did examine their stomachs to determine what they eat in the harbor. Twelve of the twenty-two walleye had semi-digested spottail shiner, stickleback, sculpin and alewife. There were no salmonids in their stomachs. This again indicates that the walleye feed on smolts when they are in abundance around them.

The Milwaukee River downstream of the former North Avenue Dam location is channelized and has very little submerged macrophytes for young fish to take refuge. When there is an abundance of smolts in the area, walleye seem to prey on them actively. Based on the proportion of stomachs and number of Chinook salmon smolts consumed, the estimated loss of smolts due to predation varied from 1,123 to 30,162 in 1996 and 1997, respectively. Since there was no information on the annual survival rate of walleye, we used the entire number of walleye stocked for the calculation purpose. Therefore, the estimated loss may be inflated. The information gained through this study was critical in developing alternate strategies of stocking to eliminate or minimize the predatory impact on the recently stocked Chinook salmon smolts (WDNR 1998). In 1998, WDNR changed the location of stocking Chinook salmon smolts from below the former North Avenue Dam to McKinley Marina. In addition, with the cooperation of the Milwaukee Area Great Lakes Sport Fisherman Club, the smolts were held overnight in a net pen (made of 6.35 mm delta mesh webbing secured on a rectangular metal frame of 6 m long, 1.8 m wide and 1.5 m deep) before releasing to facilitate acclimatization to the receiving water. Ever since the stocking location was changed, we have not encountered any predatory impact on the Chinook salmon smolts immediately after stocking (Table 4).

These two years of study provided valuable information on the predatory behavior of walleye and their potential impact on the stocked salmonid smolts.

## 6.0 MARKING EVALUATION

An additional component of the study was the Visible Implant Elastomer (VIE) marking technique evaluation, which is detailed in a separate publication (Thompson et. al., in press).

### *6.1 Marking method*

Elastomer is a colored, viscous latex fluid injected into tissue beneath the skin. Northwest Marine Technology, Inc. of Washington State developed this technology. Walleye stocked from 1995 to 2001 were given a specific mark (fin clip or VIE mark) to identify their year-class (Table 2). As part of the marking evaluation, one half of the fish stocked were given a fin clip and the other half were marked with a colored VIE injected under the jaw. Marked fish were held in the hatchery for 10-14 days before transportation to stocking location. At the time of release, we sub-sampled 200 fish to estimate the mark retention at the time of stocking. Since 1995 there have been a total of 20,314 stocked walleye marked with VIE using a different color each year that would readily separate the year classes. This allowed us to evaluate the survival and growth rates of these marked walleye and detect differences between the two marking techniques.

### *6.2 Results*

Post marking mortality in the hatchery in the first 14 days was less than 1%. Tag retention at the time of stocking was 97%. Fin clipped walleye were stocked on the day following finclipping and there was 100% accuracy in finclipping. As the walleye grew older the fin clips were accurately readable even though there were some instances of regeneration. We found no significant difference in growth rates between the differentially marked fish (Figure 3). We also found that tag detection in recaptured fish over the long term fell to fewer than 79% for fish originally VIE marked. A cost analysis showed that costs associated with VIE marking were ten times higher than finclipping. A single fin clip appears to be the more desirable technique for marking walleye.

## 7.0 MONITORING OF SPAWNING MIGRATION AND NATURAL REPRODUCTION

One of the goals of the walleye restoration effort was to monitor maturation and spawning of stocked walleye. Walleye are widely distributed in Wisconsin waters. Populations are sustained mostly by natural reproduction although annual stocking is widely practiced to enhance the fishery in some water bodies according to WDNR guidelines. Spawning migration occurs from mid April to mid May in Wisconsin lakes when the water temperature reaches 42 $^0$F – 50 $^0$F. In Lake Winnebago, males mature at ages 2-5 and females at 5-7 years. The walleye fingerlings stocked in the Lower Milwaukee River were from the Winnebago system, which closely matched the Great Lakes strain.

### *7.1 Sampling method and results*

We conducted spring spawning surveys using electroshocking to examine and document any natural reproduction. Beginning in spring 1998 we started seeing a few mature male and female walleye upstream of the former North Avenue Dam (Table 5). Based on the mark we identified these mature fish as being from the 1995 and 1996 year-classes. Of the 154 walleye examined in 1998, there were two ripe males (one from 1995 and the other from 1996) and one green female and one spent female, both from the 1995 year-class. In 1999 sampling, of the 43 walleye captured we recorded 3 ripe males (one from 1995 and two from 1996) and one ripe female (1996 year-class). In the 2000 assessment, we found 25 males and 20 females (out of 103 total) which belonged to the 1995 and 1996 year-classes. The 1996 year-class appeared to have survived better than other year-classes and dominated the catch until year 2000. By this time they have had 3 summers of good growth, averaging 498 mm total length. These fish contributed to the greater number of mature walleye both male and female, including 7 spent females.

Only 51 walleye were captured in 2001, of which only one was a ripe male from the 1996 year-class and three were green females, which also belonged to the 1996 year-class. No mature marked walleye (out of 118) were found in 2002. A few mature walleye from the 1998 and 2000 year-classes were found in the 2003 survey. The majority of the walleye captured were immature fish from the 2001 and 2002 year-classes. Although there were very few mature walleye in the survey in each year, the fact that there were stray occurrences of spent females lead us to believe natural reproduction may be occurring in the river. We conducted the spawning survey when water temperature and flow conditions were similar from year to year. We have not made any attempt to conduct larval surveys nor have we seen any young-of-the year walleye in our annual surveys so far. All walleye fingerlings stocked in the lower Milwaukee River thus far possess age-specific marking except in 1999. Therefore, identifying naturally reproduced walleye fingerlings should be relatively easy. Spawning assessments will be continued in the future. The population size of walleye in this system at this time is much smaller than many of the water bodies in Wisconsin which are sustained through natural reproduction alone (Terry Lychwick, WDNR, personal communication).

## 8.0 POPULATION ESTIMATES

### *8.1 Method*

The first round of extended growth walleye fingerling stocking occurred in October 1995 when 7,626 walleye fingerlings were released into the lower Milwaukee River. We used the mark-recapture method ($N = M * C/R$; where N is estimated number, M is number of marked walleye, C is the total number of captured walleye in the recapture run and R is the number of marked walleye captured) in May 1996 to estimate population size (Ricker 1975). Using a boomshocker 36 walleye were captured on 5/8/1996 and marked by removing the second spine from the spinous dorsal fin. The recapture run was conducted on 5/15/1996 when a total of 85 walleye were captured, of which 3 were marked fish (recaptures).

### *8.2 Results and discussion*

Based on the mark-recapture method the estimated walleye population at that time was 795 (Table 6). These walleye were not adults, although the population estimation coincided with the spawning assessment in the subsequent years. We repeated the population estimate effort in 1998. Although our population estimate effort included all walleye, there were some mature fish in 1998. In inland lakes mature males appear in the spawning run at age 3 (E. Randy Schumacher and Doug Welch, WDNR, personal communication). In order to increase the number of marked fish and recapture rates we employed the

Schnabel multiple capture method. We sampled for five days from 4/14/98 to 4/23/98 and marked 102 walleye and recaptured 10 during the course of sampling. In spring 1999, we put in 4 nights of electroshocking effort yet marked only 26 walleye with no recaptures. Therefore, we could not obtain a population estimate. However, population estimates were calculated for 2002 and 2003, which resulted in 428 and 875, respectively (Table 6).

## 9.0 SIZE-AT-AGE

The stocked walleye seem to be surviving and growing well in this environment. Table 6 indicates annual growth rates of walleye stocked in the Milwaukee River. Growth rates from year-class to year-class appear to be similar (Figure 4). They reached an average size of 425 mm in three years. There is sufficient forage available in the form of alewife, gizzard shad, shiners and stickleback. Also, from the radio telemetry data, it seems these walleye follow a temperature regime and take refuge in the warmer Menomonee River canals during the winter. The growth rate of these walleye (Figure 5) appears to be greater than average for walleye in Wisconsin (Nancy Nate, WDNR, personal communication).

## 10.0 SEASONAL MOVEMENT PATTERN USING RADIO TELEMETRY

### *10.1 Pilot project*

In order to examine the seasonal movement pattern of adult walleye on a large spatial scale we embarked on using radio telemetry technology. In spring 1999, we initiated a pilot radio telemetry study. By this time the previously stocked walleye had grown large enough to implant transmitters. By general rule of thumb the size of the transmitters should be less than 2% of the body weight of the receiving fish. We used refurbished transmitters and loaned equipment from another WDNR office (Table 8). The radio transmitters were surgically implanted into the body cavity after anaesthetizing the fish. Unfortunately, these refurbished transmitters lasted only for 90 days and provided us with limited data.

### *10.2 Extended telemetry effort*

In April 2000 we had a funded project to implant 15 walleye and 5 smallmouth bass with radio transmitters. Advanced Telemetry Systems, Inc. (ATS) built these transmitters to last year-round to capture seasonal movement data. We continued this effort in fall 2000 and all of 2001. All of the transmitters were programmed in such way that they were on for 12 hours from 9:30am to 9:30pm on alternate weeks. This allowed for a longer battery life. In September 2000 Walleyes Unlimited funded the purchase of new tracking and data collection equipment. We posted signs all along the river informing anglers about the study. Anglers are requested to handle these study fish gently and release them if they are caught.

Each year we divided the total number of walleyes implanted into two batches. One batch of walleye implanted with radio transmitters was released in the Milwaukee River below the former North Avenue Dam and the other batch was released at the Summerfest lagoon in the Milwaukee Harbor. These locations are geographically separated by about 10 km and represent different habitat types. The data were collected on alternate weeks by going out on boat, canoe or often from the shore. These data were analyzed using a Geographic Information System (GIS) software.

### *10.3 Preliminary results*

The radio telemetry data have provided valuable information on the movement pattern of walleye in the Milwaukee River and Harbor for the first time (Figure 6). The fish that were released in the river stayed upriver during the spring and early summer. As the summer progressed these fish moved out of the river and were subsequently found in the harbor, especially in the lagoon east of the Summerfest grounds. This was probably due to the increased water temperature in the river causing the fish to seek refuge in the deeper, cooler harbor water. By coincidence, this movement pattern helps keep adult walleye away from Chinook salmon smolts when they are stocked in the harbor in late spring. The preliminary data on the seasonal movement also indicate that the adult walleye follow a temperature regime and take refuge in the warmer Menomonee River canals during late fall and in winter. A nearby electric power plant discharges warm water into these canals. The radio telemetry study showed a clear seasonal and spatial movement pattern. A more thorough examination of the walleye movement patterns will be conducted in a future document.

## 11.0 ANGLER RESPONSE

Overall, angler response in this area is very positive. From our creel survey and also from general observation, it seems anglers are targeting walleye in several areas, especially by the former North Avenue Dam, Menomonee River canals, and Summerfest lagoon. Creel survey data indicate a sharp increase in the directed angling effort for walleyes in 1997 and 1998, the second and third years of the current reintroduction effort (Table 9). This increase is due to the greater interest in the fishery by the public and the availability of sufficient numbers of creel-sized fish. Similar trends are evident for total catch and harvest per hour rates. An increase in these same parameters for the Menomonee River in 2002 is due to the expansion of the creel survey to include this area. It is likely that significant angler effort and harvest was occurring in the Menomonee Canals prior to their inclusion in the creel survey. Although most anglers seem to practice catch-and-release fishing, there appears to be substantial harvest. The low population estimates could be due to a combination of factors controlling survival, dispersal, and removal from the system.

## 12.0 MANAGEMENT IMPLICATIONS

Angler response to the renewed opportunity to fish walleye in the area is positive and very encouraging. The majority of anglers we have talked to follow catch and release practices. With the complete removal of the North Avenue Dam in 1997, the Milwaukee River opened up an additional 9.6 km of river for fishing. The most popular areas to fish are near the former North Avenue

Dam, Estabrook Park, Kletzsch Park, and also along the Menomonee River canals. Increased creel effort throughout the lower Milwaukee River and Harbor would help to better quantify exploitation rates.

The WDNR has enhanced habitat quality in certain areas by adding some habitat improvement structures and bank stabilization features. At this point, the goal of the WDNR is to continue stocking 10,000 extended growth walleye fingerlings through 2004. Extended growth walleye fingerlings appear to have better survival as evidenced by some of the lakes in New York State (Brooking et al. 2002). The concern of trout and salmon fishermen regarding predation impact on stocked salmonid smolts was addressed in the 1998 plan with appropriate alternative strategies. The results from our continued evaluation of predatory impact since 1998 indicated no direct impact on the smolts immediately after releasing due to predation. We will also continue to monitor their growth, movement, survival, natural reproduction and impact on stocked salmonid smolts.

Based on the data on growth, survival, movement patterns, impact on other species and angler response, we believe that the project has lived up to its positive expectations. Shore anglers frequently report catching walleye on the Milwaukee River all the way up to Kletzsch Park, as well as on Menomonee River and its canals. The growth rates seem to be equal to or better than most of the walleye populations around the state. The future direction for the walleye population restoration in the lower Milwaukee River will be discussed after all phases of the 1998 plan are completed.

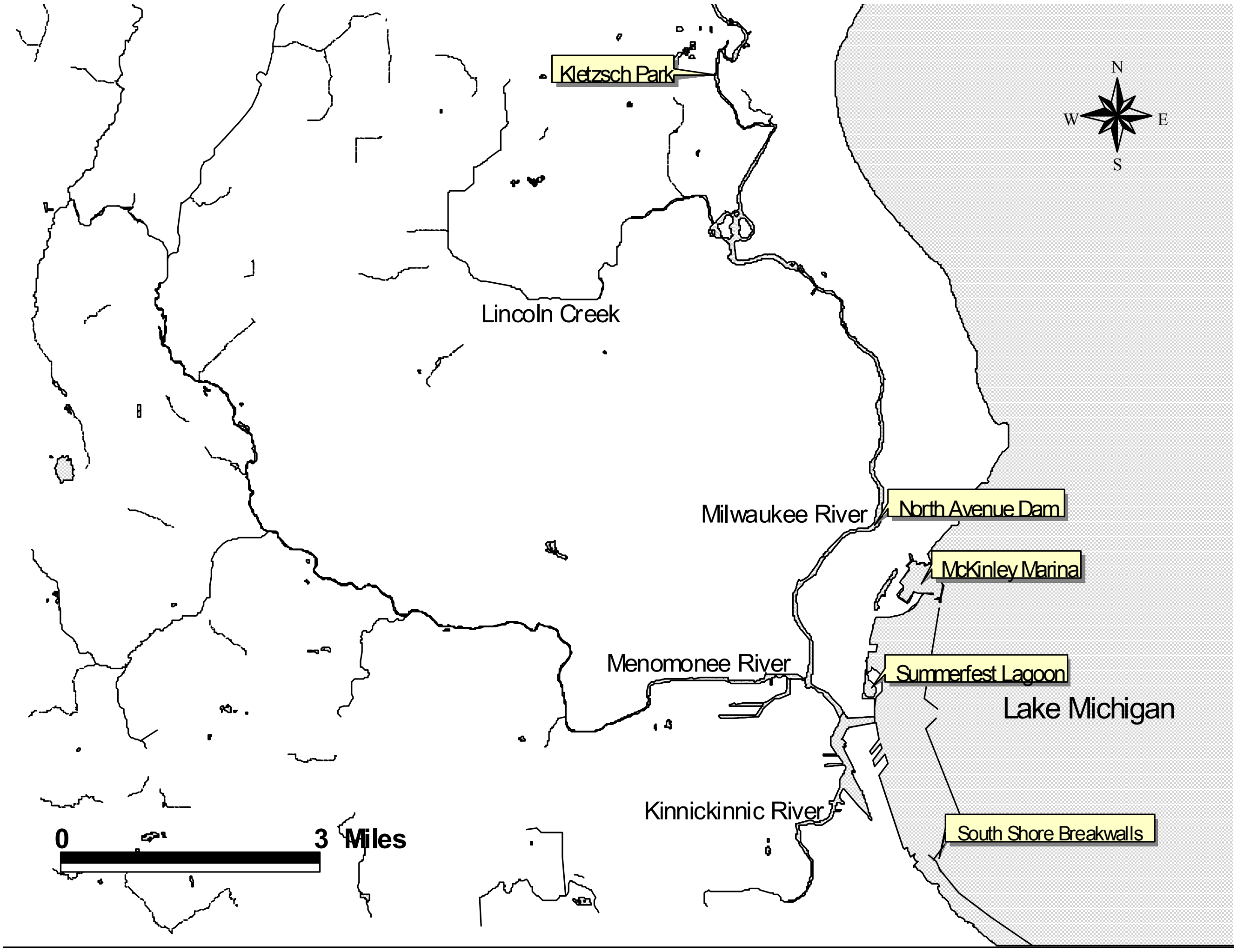


**Figure 1.** Study area, including Milwaukee, Menomonee and Kinnickinnic Rivers, and the Milwaukee Harbor.

**Table 1.** Historical records of walleye stocking in the Milwaukee Harbor and vicinity.

| Year | Number | Size | Stocking site |
|---|---|---|---|
| 1986 | 2,000,000 | Fry | Milwaukee River |
| 1988 | 2,920,000 | Fry | Milwaukee Harbor |
| 1990 | 2,500,000 | Fry | Milwaukee Harbor |
| | 1,000 | Yearling | Milwaukee Harbor |
| | 1,000 | Yearling | South Milwaukee |
| | 1,000 | Yearling | Fox Point |
| | 1,000 | Yearling | Milwaukee South Shore Yacht Club |
| | 1,000 | Yearling | Milwaukee Green Can Reef |
| 1991 | 550 | Age 2 | Milwaukee Harbor |
| 1992 | 2,300,000 | Fry | Milwaukee Harbor |

**Table 2.** Number of walleye fingerlings stocked in the lower Milwaukee River below the former North Avenue Dam.

| Year | # stocked | Age at stocking | Source | Strain | Mark type |
|---|---|---|---|---|---|
| 1995 | 7,626 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Unknown | RP/REL |
| 1996 | 9,972 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Unknown | LP/GEL |
| 1997 | None | | | | |
| 1998 | 3,155 | Extended growth fingerlings[1] | Private Hatchery | Lake Michigan | RV/BEL |
| 1999 | 7,700 | Fingerlings[2] | WDNR Kettle Moraine Springs Hatchery | Lake Michigan | None |
| 2000 | 9,880 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Lake Michigan | LV/OEL |
| 2001 | 10,000 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Lake Michigan | RP/PEL |
| 2002 | 5,600 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Lake Michigan | LP |
| 2003 | 11,000 | Extended growth fingerlings[1] | WDNR Spooner Hatchery | Lake Michigan | RV |

[1] Extended growth fingerlings (average size 150-180mm total length)
[2] Fingerlings (average size 64mm total length)

_Legend_:

RP = right pectoral fin clip
LP = left pectoral fin clip
RV = right ventral fin clip
LV = left ventral fin clip

REL = red elastomer
GEL = green elastomer
BEL = blue elastomer
OEL = orange elastomer
PEL = purple elastomer

**Table 3.** Monetary support for walleye restoration efforts in the lower Milwaukee River. (This does not include any equipment or labor provided by clubs.)

| Date | Source | Purpose | Amount |
|---|---|---|---|
| June 1995 | Lakeshore Fisherman Sports Club | Initial funding to raise 10,000 extended growth walleye fingerlings and to evaluate their impact. | $10,000 |
| July 1996 | Lakeshore Fisherman Sports Club, and Lakeridge Boat Club (joint offer) | Continuation of the project | $2,500 |
| 1997-98 | WDNR annual funding | Approved project costs | $2,812.50 |
| 1998-99 | WDNR annual funding | Approved project costs | $2,812.50 |
| Oct. 1998 | Walleyes for Tomorrow | Paid private hatchery to raise extended growth walleye fingerlings | unknown |
| 1999-00 | WDNR annual funding | Approved project to cover the cost of evaluation, radio telemetry, and marking evaluation | $15,650 |
| 2000-01 | WDNR annual funding | Approved project to cover the cost of evaluation, radio telemetry, and marking evaluation | $15,650 |
| 2000 | Walleyes for Tomorrow | Funded WDNR to cover the cost of raising extended growth walleye fingerlings | $5,000 |
| Sept. 2000 | Walleyes Unlimited | Funded to purchase new radio tracking equipment | $2,800 |
| Mar. 2001 | Lakeridge Boat Club | Funded to purchase equipment for fish age determination | $4,000 |
| 2001 | Walleyes for Tomorrow | Funded WDNR to cover the cost of raising extended growth walleye fingerlings | $5,000 |
| 2001-02 | WDNR annual funding | Approved project to cover the cost of evaluation, radio telemetry, and marking evaluation | $8,347 |
| 2002 | Walleyes for Tomorrow | Funded WDNR to cover the cost of raising extended growth walleye fingerlings | $5,000 |
| 2002-03 | WDNR annual funding | Approved project to cover the cost of evaluation, radio telemetry, and marking evaluation | $9,867 |
| 2003 | Walleyes for Tomorrow | Funded WDNR to cover the cost of raising extended growth walleye fingerlings | $5,000 |

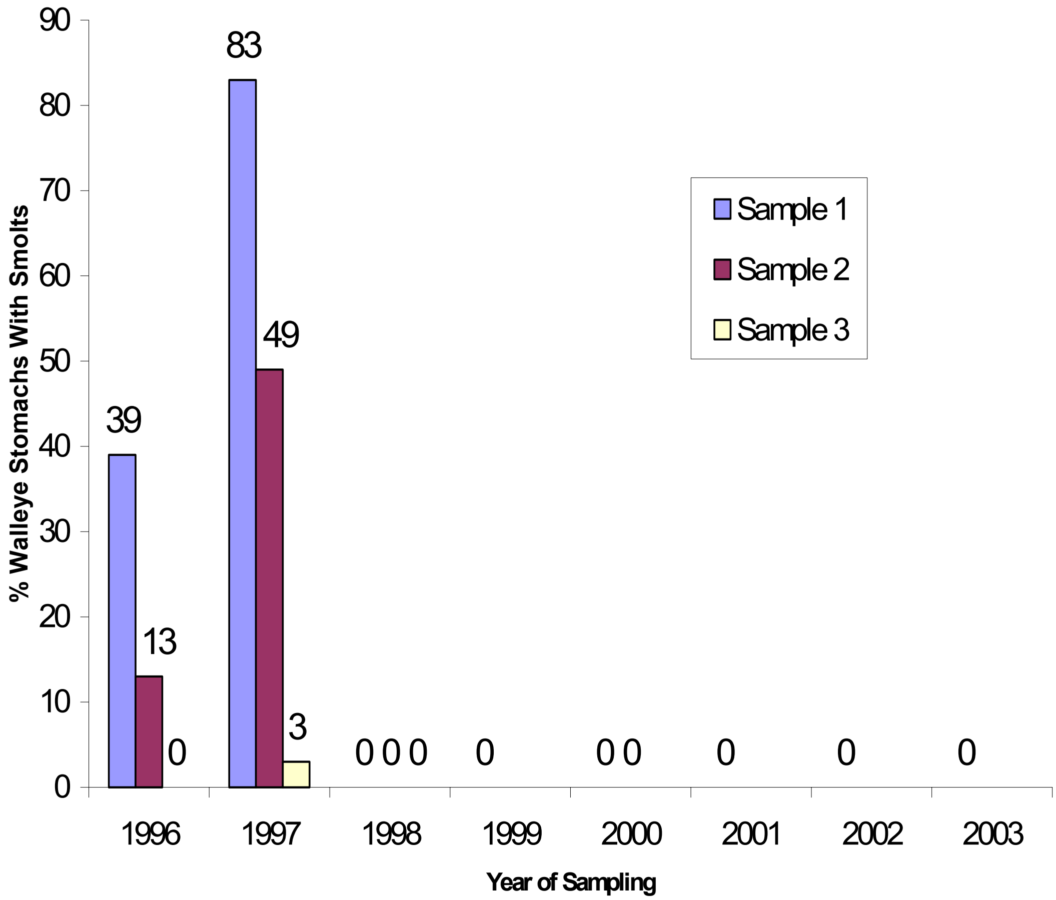


**Figure 2.** Predation impact by stocked walleye on stocked Chinook salmon smolts expressed as percentage of walleye stomachs containing smolts in the Milwaukee River.

**Table 4.** Predatory impact on the stocked salmonid smolts in the lower Milwaukee River and Harbor.

| Year | # Chinook stocked | Stocking location | Impact |
|---|---|---|---|
| 1996 | 144,250 | Below N. Avenue Dam | Moderate |
| 1997 | 181,000 | Below N. Avenue Dam | High |
| 1998 | 145,000 | McKinley Marina | Nil |
| 1999 | 144,000 | McKinley Marina | Nil |
| 2000 | 143,900 | McKinley Marina | Nil |
| 2001 | 151,000 | McKinley Marina | Nil |
| 2002 | 122,300 | McKinley Marina | Nil |
| 2003 | 145,000 | McKinley Marina | Nil |

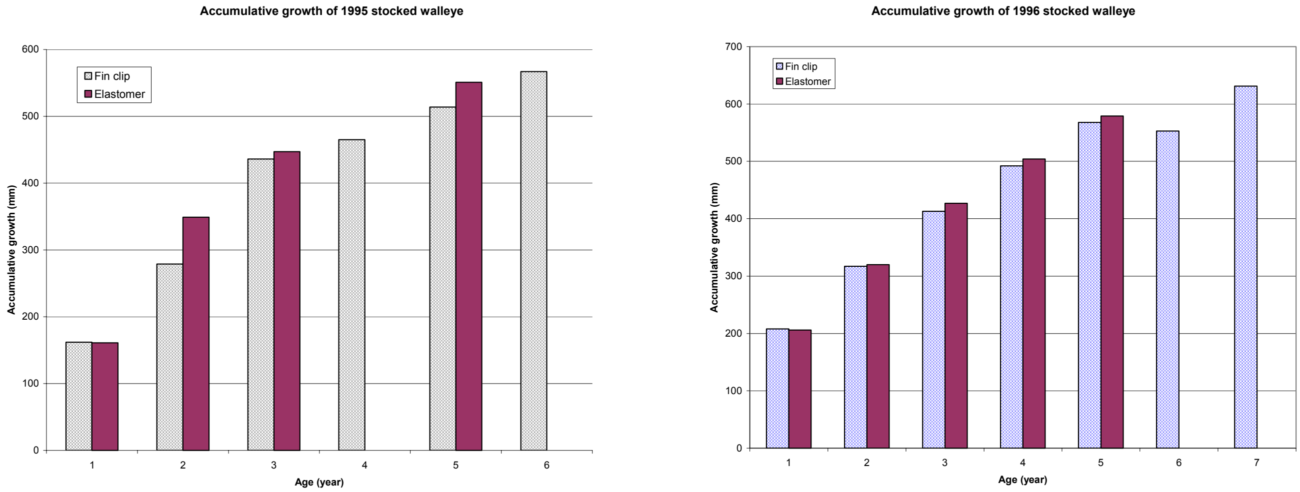


**Figure 3.** Comparison of accumulative growth for 1995 and 1996 year-class between finclipped and VIE marked walleye in the lower Milwaukee River and Harbor.

**Table 5.** Walleye spawning assessment in the lower Milwaukee River from 1998 to 2003.

| YEAR | Total walleye | Number of males | | | Number of females | | |
|---|---|---|---|---|---|---|---|
| | | Green | Ripe | Spent | Green | Ripe | Spent |
| 1998 | 154 | 0 | 2 | 0 | 1 | 0 | 1 |
| 1999 | 43 | 0 | 3 | 0 | 0 | 1 | 0 |
| 2000 | 103 | 5 | 20 | 5 | 20 | 0 | 7 |
| 2001 | 51 | 0 | 1 | 0 | 3 | 0 | 0 |
| 2002 | 118 | 0 | 2 | 0 | 0 | 1 | 0 |
| 2003 | 127 | 0 | 7 | 0 | 3 | 0 | 1 |

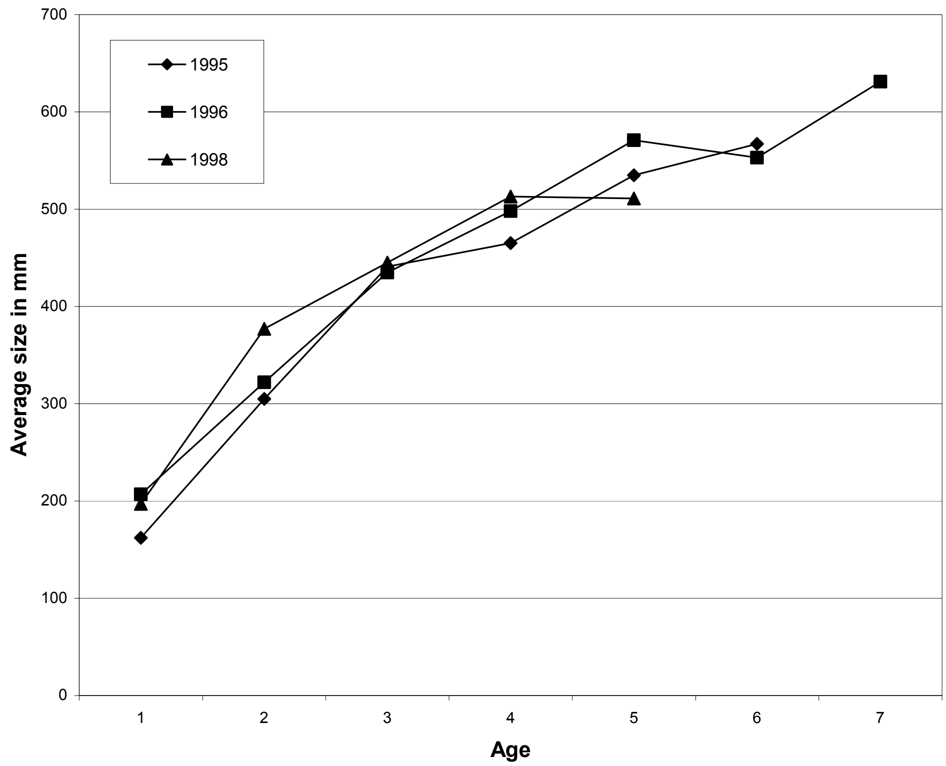


**Figure 4.** Growth pattern in three different year-classes of walleye stocked in the lower Milwaukee River.

**Table 6.** Population estimate of walleye (all sizes) in the lower Milwaukee River.

| Assessment year | Estimated walleye | 95% confidence interval | Method (Ricker 1975) | Comment |
|---|---|---|---|---|
| 1996 | 795 | 115$\leq$ N $\leq$ 1475 | Chapman Modification of a Petersen method | No adult fish |
| 1998 | 745 | 405$\leq$ N $\leq$ 1586 | Schnabel multiple capture | All walleye |
| 2002 | 428 | 129 $\leq$ N $\leq$ 727 | Chapman Modification of a Petersen method | All walleye |
| 2003 | 875 | 401$\leq$ N $\leq$ 2388 | Schnabel multiple capture | All walleye |

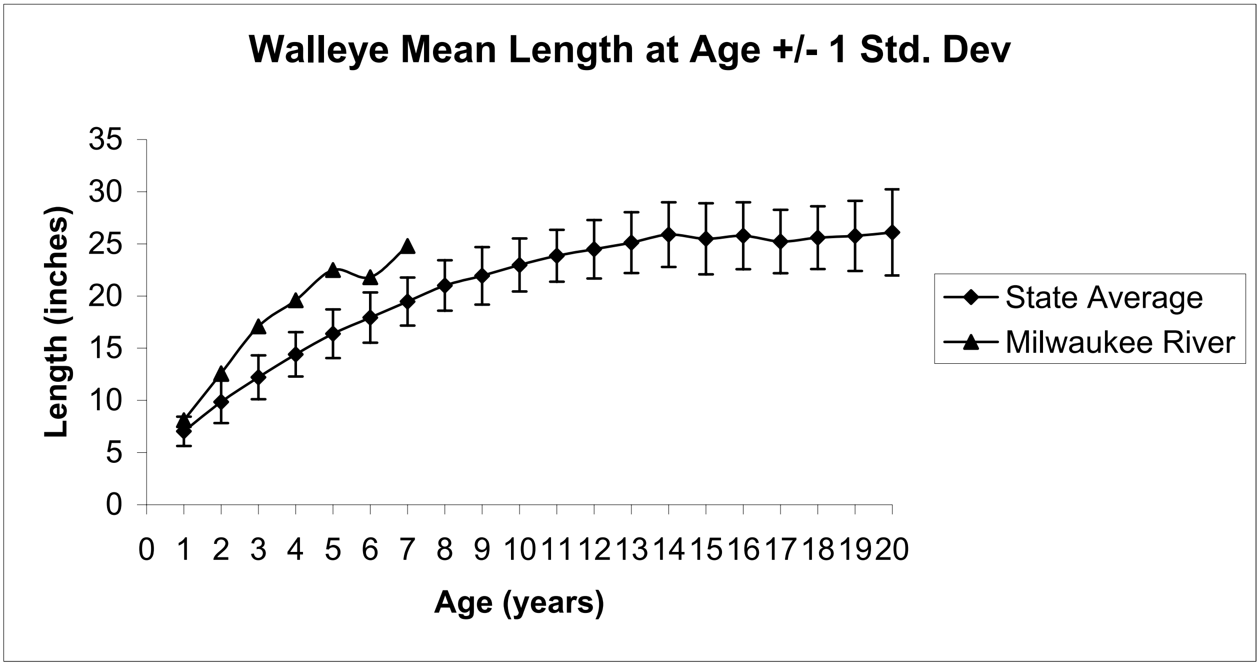


**Figure 5.** Comparison of walleye growth between the Milwaukee River and Harbor and the statewide average (Nancy Nate, WDNR, Bureau of Fisheries Management and Habitat Protection).

**Table 7.** Size-at-stocking and size-at-capture of walleye stocked in the lower Milwaukee River and Harbor.

| Year of Stocking | Mark type<br>Finclip<br>Elastomer | Average size at stocking (mm) | Average size (mm) at capture | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 |
| 1995 | RP | 163 | 162 (69) | 279 (5) | 436 (16) | 465 (1) | 514 (3) | 567 (1) | - | - |
| | REL | 160 | 161 (85) | 349 (3) | 447 (13) | - | 551 (4) | - | - | - |
| 1996 | LP | 185 | | 208 (74) | 317 (47) | 413 (17) | 492 (32) | 568 (7) | 553 (5) | 631 (1) |
| | GEL | 188 | | 206 (77) | 320 (55) | 427 (9) | 504 (31) | 579 (3) | - | - |
| 1998 | RV | 166 | | | | 221 (2) | 375 (8) | 448 (7) | 501 (6) | 509 (2) |
| | BEL | 173 | | | | 173 (2) | 380 (5) | 438 (3) | 572 (1) | 518 (1) |
| 2000 | LV | 197 | | | | | | 368 (5) | 388 (9) | 466 (5) |
| | OEL | 193 | | | | | | - | 322 (1) | - |
| 2001 | RP | 189 | | | | | | | 192 (54) | 320 (15) |
| | PEL | 188 | | | | | | | 193 (21) | 322 (10) |
| 2002 | LP | 195 | | | | | | | | 202 (78) |

*Legend*:

RP = right pectoral fin clip
LP = left pectoral fin clip
RV = right ventral fin clip
LV = left ventral fin clip

REL = red elastomer
GEL = green elastomer
BEL = blue elastomer
OEL = orange elastomer
PEL = purple elastomer

Note: Number in parenthesis is the sample size

**Table 8.** Number and species of fish implanted with radio transmitters.

| Date of implanting | # of transmitters | Species |
|---|---|---|
| May 1999 (pilot project) | 9 (refurbished) | Walleye |
| April 2000 | 15 | Walleye |
| April 2000 | 5 | Smallmouth bass |
| September 2000 | 11 | Walleye |
| May 2001 | 10 | Walleye |
| May 2001 | 5 | Smallmouth bass |

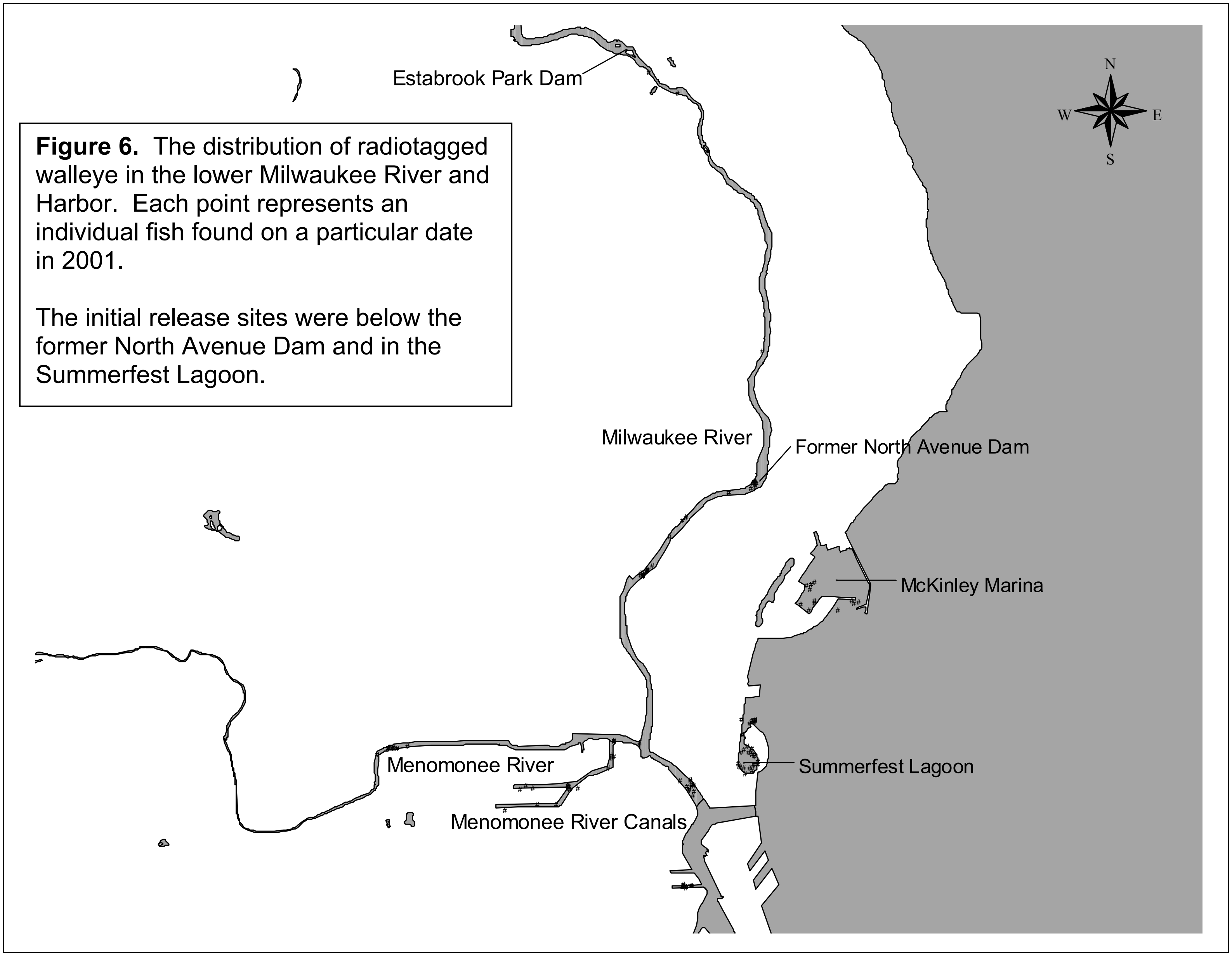


**Figure 6.** The distribution of radiotagged walleye in the lower Milwaukee River and Harbor. Each point represents an individual fish found on a particular date in 2001.

The initial release sites were below the former North Avenue Dam and in the Summerfest Lagoon.

**Table 9.** Total directed angling effort (hours) for walleye from March 15 through October 31, 1990 to 2002 in the lower Milwaukee River, Menomonee River canals and the harbor.

| Creel survey year | Fishery type | | | | | |
|---|---|---|---|---|---|---|
| | Ramp | Pier | Shore | Stream | | |
| | | | | Downstream of the Dam | Upstream of the Dam | Menomonee River /canals |
| 1990 | 0 | 0 | 696 | 0 | 0 | NA |
| 1991 | 0 | 0 | 167 | 0 | 0 | NA |
| 1992 | 0 | 0 | 13 | 0 | 0 | NA |
| 1993 | 0 | 0 | 13 | 0 | 0 | NA |
| 1994 | 0 | 122 | 23 | 0 | 116 | NA |
| 1995 | 0 | 0 | 0 | 0 | 0 | NA |
| 1996 | 0 | 0 | 148 | 0 | 0 | NA |
| 1997 | 0 | 18 | 734 | 1606 | 221 | NA |
| 1998 | 871 | 0 | 3,551 | 0 | 0 | NA |
| 1999 | 0 | 34 | 360 | 0 | 0 | NA |
| 2000 | 0 | 0 | 242 | 0 | 222 | NA |
| 2001 | 0 | 0 | 67 | 0 | 0 | 109 |
| 2002 | 0 | 328 | 632 | 285 | 175 | 2,652 |

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